PB-228 595

WASTE DISPOSAL STUDIES, DOVER AIR FORCE BASE, DOVER, DELAWARE

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

June 1965

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WASTE DISPOSAL STUDIES

DOVER AIR FORCE BASE
Dover, Delaware

July and October, 1964

U. S. Department of Health, Education, and Welfare
Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

June, 1965

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APPENDIX

(1) Letter dated April 20, 1964 from Col. Lloyd R. Humphreys, Base Commander, Dover Air Force Base (MATS), U. S. Air Force, Dover, Delaware to Earl J. Anderson, Regional Program Director, U. S. Public Health Service, New York.

(2) Letter dated May 24, 1965 from Earl J. Anderson, U. S. Public Health Service, Region II, New York, to Floyd I. Hudson, M. D., Executive Officer, Water Pollution Commission, Dover, Delaware.

(3) Letter dated May 27, 1965 from N. C. Vasuki, Water Pollution Commission, Dover, Delaware to Earl J. Anderson, U. S. Public Health Service, Region II, New York.

(4) Letter dated February 15, 1965 from John C. Bryson, Director, Water Pollution Commission, State of Delaware, Dover, Delaware, to Col. David E. Daniel, 160th Air Transport Wing, Dover Air Force Base, Dover, Delaware.

SUMMARY AND CONCLUSIONS

During July and again in October, 1964, studies were made on the industrial wastes being discharged by the Dover Air Force Base. In October, studies were conducted on the disposal of sanitary wastes from the Base. Biological studies of the receiving waters were made during the period September 29 to October 2, 1964.

Previous findings of the quality of industrial wastes discharged from the Base, and findings of the 1964 biological studies of the receiving waters indicate that Little River and Pipe Elm Branch, a tributary to Little River, have been heavily polluted in the recent past. Results of the 1964 studies as compared to previous data indicate that considerable improvement has been accomplished in the disposal of industrial wastes from the Base. However, the improvements have not been sufficient to meet the objectives of the Water Pollution Commission of the State of Delaware.

The chemical data obtained by the industrial waste studies indicate that the objectives were exceeded during the studies by the concentrations of phenol, cyanide, chemical oxygen demand,

chromium, copper, ABS (detergent) and oil.

All of Pipe Elm Branch and portions of Little River were biologically degraded because of the oily, greasy sludge that covered the bottom. These deposits affect the bottom life by smothering or toxic action, or both. The sparse population of free-living forms, such as fish, in the polluted areas gave indication of the presence of toxic materials. It cannot be determined from the biological data collected if the toxic materials were emanating from deposits of past pollution, or if they were still being discharged at toxic levels.

Sanitary wastes from the Base are discharged to the St. Jones River. The two basins, St. Jones and Little Rivers, divide the Air Base. Chemical data obtained on the disposal of sanitary wastes from the Base indicate that the disposal plant was operating at an efficiency of about 25 per cent reduction of biochemical oxygen demand. This level of reduction is quite low for a primary type treatment plant. Coliform bacteria densities in the discharge, when chlorination was not being provided, exceeded one million per 100 milliliters.

The Water Pollution Commission of the State of Delaware requires secondary type treatment and chlorination of all sanitary wastes discharged to the St. Jones River. Secondary treatment implies about 85 per cent removal of B.O.D.

The point of discharge of the sewage treatment plant is under tidal influence of the St. Jones. The stream was examined biologically

at points one-half mile downstream and one-half mile upstream of the discharge. At both points the river was biologically degraded. The Dover Air Force Base sewage treatment plant effluent contributed to the pollution and degradation of the St. Jones River both above and below its outfall.

RECOMMENDATIONS

INDUSTRIAL WASTES

Additional treatment should be provided for wastes from the engine build up shop. Reduction of ABS, oil, phenolics, cyanide, chemical oxygen demand, and the heavy metals must be improved to meet the levels deemed acceptable by the State.

Improvements in operation and possible additions to the treatment unit for the aircraft wash racks should be provided.

Due to the low flows encountered in the receiving stream consideration should be given to providing a closed system, and recirculating the wastes for re-use.

The curbing around the cadmium plating operations must be sealed to prevent accidental spills or leaks from getting into the storm sewer. In addition, the wastes from the cadmium plating shop should be discharged to the lagoons or other treatment device or to a tank for disposal by means of scavenger services.

A surveillance program should be established by the Base to ensure that acceptable levels of industrial waste pollutants are maintained at all times.

Final plans for construction and operation should be reviewed by the Public Health Service.

SEWAGE DISPOSAL PLANT

Improved operations of the existing sewage treatment plant are needed. Adequate continuous chlorination must be provided.

To comply with State requirements the plant will have to be expanded or replaced by a secondary type treatment plant.

PERSONNEL

It is recommended that a continuity in personnel be maintained in operating both domestic and industrial facilities at this installation. Operating personnel should have the necessary training and experience to operate existing and future treatment facilities, and they should be responsible to qualified permanent personnel.

GENERAL INFORMATION

AUTHORITY

The request for the services of the U. S. Public Health Service to conduct studies of waste disposal facilities at Dover Air Force Base was made by letter dated April 20, 1964 and signed by Lloyd R. Humpheries, Colonel, U. S. Air Force. The letter was addressed to Mr. Earl J. Anderson, Public Health Service, Region II, New York (See Appendix).

OBJECTIVES

The objectives of the studies were to

(1) determine the quantity and contents of wastes being discharged from Dover Air Force Base,

(2) determine what improvements had been accomplished by operational changes since 1963,

(3) advise the Air Base of acceptable levels of waste materials that may be discharged.

STUDY DATES

The first study was conducted during the period July 26 to August 1, 1964 inclusive. The second study period was started on September 27. Due to heavy rains this study was interrupted on September 29, and resumed on October 6, and continued through October 9.

The necessity of two study periods was the result of a change-over in cleaning operations in the engine build up shop.

Biological studies were made on Little River and St. Jones River from September 29 through October 2.

PERSONNEL

The following participated in the studies:

Delaware Water Pollution Commission
John C. Bryson, Director

Dover Air Force Base Hospital Staff
Lt. Col. B. R. Baker, Director, Base Medical Services

Dover Air Force Base Civil Engineers' Office
Lt. Col. James F. Conti, Base Civil Engineer

U. S. Public Health Service
Region II Office, New York
Earl J. Anderson, Regional Program Director

U. S. Public Health Service
Robt. A. Taft Sanitary Engineering Center
Cincinnati, Ohio
Technical, Advisory and Investigations Section
A. D. Sidio, Public Health Engineer
Carl Hirth, Chemist
Jack Geckler, Biologist

LABORATORY FACILITIES AND ANALYSES

The Delaware Water Pollution Commission provided laboratory space in their laboratory facilities at Dover, Delaware.

Laboratory analyses on industrial wastes at the Dover laboratory included pH, detergents (ABS), oil, phenols, and cyanide. Samples were preserved and returned to Cincinnati for determinations of chemical oxygen demand, chromium, copper, cadmium, nickel, and zinc. Analyses were performed by personnel of the Base Civil Engineer's Office, the Delaware Water Pollution Commission, and the U. S. Public Health Service.

Five-day 20° Centigrade B.O.D. analyses and total coliform determinations were made on the sanitary sewage disposal plant influent and discharge. Samples from the sewage disposal plant were composited over 2, 8-hour periods each for four and one-half days. The samples were collected by personnel of the Base Civil Engineer's Office. Chemical analyses and coliform determinations on the sewage disposal plant samples were made by personnel of the Delaware Water Pollution Control Commission.

WATER USES

The St. Jones River was, in the past, used for considerable shipping. Presently it is navigable almost up to the city of Dover and used mostly by deep sea fishing boats which are docked inland. Though Little River is quite shallow in some places, numerous commercial fishermen, especially crabbers, dock at the community of Little Creek.

Agriculture is a primary industry in the St. Jones River Basin. Normally rainfall is adequate, however, farmers have found frequent need for irrigation of crops during dry periods. In the tidal portions of the Little River Basin, water is sometimes drawn for irrigation in dry weather, preferably during ebb tide.

There are limited oyster beds in the St. Jones River near its mouth. There are extensive oyster beds in the Delaware Bay just offshore between the mouths of the St. Jones and Little Rivers. These beds are among the finest in the Delaware Bay. Crabbing is conducted in both the St. Jones and Little Rivers. The community of Little Creek, on Little River, is noted as a center for the crabbing industry.

The St. Jones River is used for the disposal of treated sanitary sewage from the city of Dover, Delaware State College, and the Dover Air Force Base. Both the city of Dover and Delaware State College use secondary type treatment (85 per cent biochemical oxygen demand reduction). Dover Air Force Base has primary treatment.

Industrial wastes are discharged to Little River from the Dover Air Force Base. Industrial wastes are produced at three sources on the Base. All three drain to the North Ditch, which drains to Pipe Elm Branch, a tributary to Little River. A schematic diagram of the industrial waste flow is shown on Chart 1. In addition, storm and subsurface drainage of the runway and plane operations area drain to the North Ditch. Industrial wastes discharged from the Base represent almost the entire waste load being discharged to the Little River Drainage Basin.

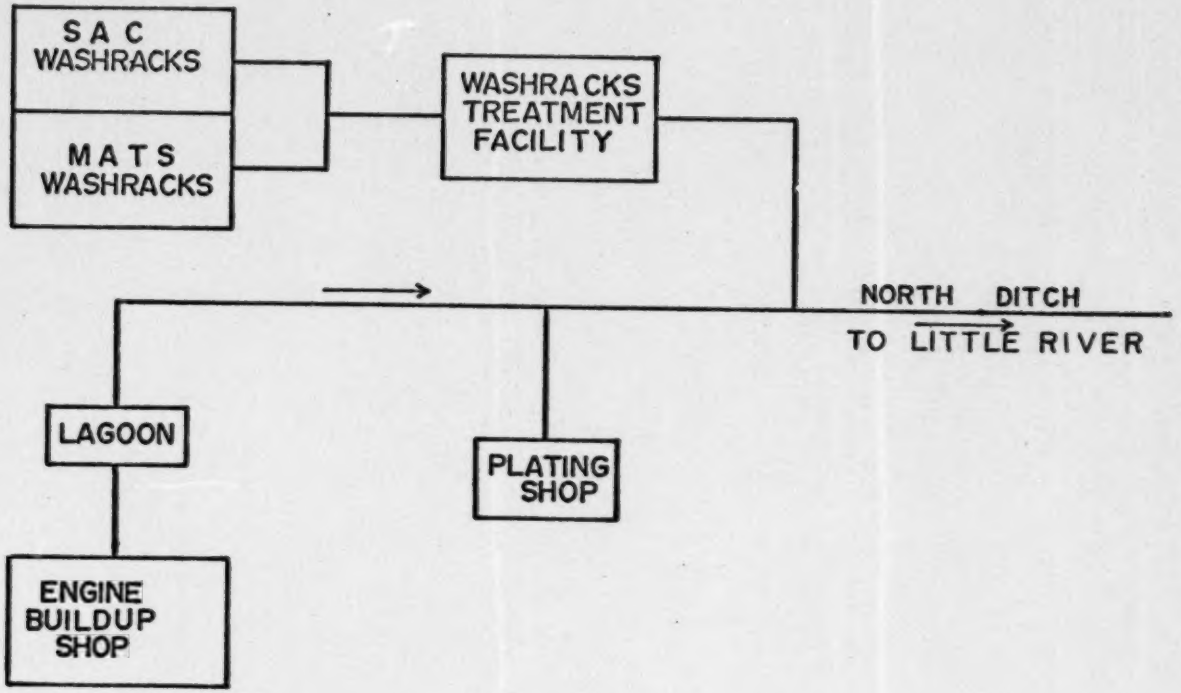

CHART I

SOURCES OF INDUSTRIAL WASTES
DOVER AIR FORCE BASE

DOVER, DELAWARE

STATE REQUIREMENTS

REQUIREMENTS

The Water Pollution Commission of the State of Delaware has agreed to a list of objectives on waste materials that may be discharged to Little River (See Appendix). It is intended that these limits apply to the wastes discharged from the Base by the North Ditch.

The objectives are as follows:

Phenol	0.1 lbs./day
Chromium	0.05 lbs./day
Chemical Oxygen Demand	25 lbs./day
Copper	0.10 lbs./day
Alkyl Benzene Sulfonate	1.67 lbs./day
Cyanide	0.02 lbs./day
Cadmium	0.03 lbs./day
Nickel	0.33 lbs./day
Zinc	8.32 lbs./day
Floating Oils	NONE
Total Oils	25 lbs./day

Whenever new pollutants appear in the waste discharges as a result of new processes or methods, upper limits for these new pollutants should be established.

In the St. Jones River the Delaware Water Pollution Commission now requires secondary type treatment and chlorination for all sanitary wastes. The Base Commander has been notified of this requirement by the Commission (See Appendix).

COMPLIANCE WITH REQUIREMENTS

In accordance with the objectives of the Water Pollution Commission of the State of Delaware, the wastes emanating from the Dover Air Force Base exceeded the limits in the following:

1. Phenol exceeded the limits of 0.1 lbs./day in 3 out of 5 samples during the latter study of 1964. The highest value was 3 pounds per day.
2. Chemical Oxygen Demand exceeded the limit of 25 lbs./day in all samples collected during the 1964 studies. The average was 8 times the objective limits.
3. Values of cyanide in the North Ditch exceeded the objective limits in 2 out of 9 samples.
4. Chromium values in the North Ditch exceeded the limit of 0.05 lbs./day in 4 out of 5 samples during the latter study of 1964. The 4 samples ranged from 0.2 to 0.3 lbs./day.
5. Copper was present in only one of twelve samples from the North Ditch. That sample contained 0.67 lbs./day.
6. Cadmium, Nickel and Zinc did not exceed the objectives at any time in the North Ditch.

7. Oil exceeded the objective of 25 lbs./day in ten of twelve samples from the North Ditch. A maximum of 132 lbs./day was discharged from the Base.

8. ABS exceeded the objective limit in 10 out of 12 samples. The average value of 3.2 lbs./day was about twice the objective level of 1.67 lbs./day.

9. The sewage treatment plant is a primary treatment plant. Secondary treatment of sanitary wastes is required by the State.

10. The sewage treatment plant discharge was chlorinated only during the day shift. Continuous chlorination of the discharge is required.

SOURCES AND DESCRIPTION OF WASTES

ENGINE BUILD UP SHOP

The major source of industrial waste is the engine build up shop. The waste is produced in the cleaning of aircraft engine parts. The shop operates 24 hours per day, 7 days per week.

The chemicals and procedure used in cleaning the parts were changed about the first of September 1964. It had been anticipated that the change would occur prior to June 1, 1964. The July study was planned with the thought that the change-over would have been made and that the treatment facilities would have adjusted to the change prior to the study. One reason for the change was to reduce the strength of waste produced.

Parts coming in for cleaning are put through carbon removal, rust removal, and paint removal procedures as necessary. Two additional parts-cleaning operations are used that do not produce waste waters.

The waste-producing operations include the use of the following chemicals and procedures:

I. Carbon Removal.

A. Parts precleaned in paint removing room in PS-661 bath (approximately 300 gallons). (PS-661 - aliphatic naphtha-saturated aliphatic hydrocarbon similar to kerosene, flammable, insoluble in water)

B. Steam cleaning (no surfactant added to steam).

C. Hot dip carbon remover PC-111a (800 gallons). (PC-111a - ethylene glycol monobutyl ether, diethylene glycol diethyl ether, monoethanol amine)

D. Hosed off with water.

II. Rust Removal.

A. If parts are greasy, precleaned with PS-661 in paint removing room.

B. Parts cleaned with water-base alkaline cleaner, MIL-D-26549 (MIL-D-26549 - alkaline scaling solution, chemical constituents not available -- listed as highly caustic, non-flammable).

C. Hosed off with water.

D. Alkaline permanganate bath (800 gallons - sodium carbonate 20 oz. per gallon water, sodium hydroxide 20 oz. per gallon water, potassium permanganate 10 oz. per gallon water).

E. Hosed off with water.

F. Nitric acid bath (800 gallons - one part 42° Baumé nitric acid to three parts water).

G. Hosed off with water.

III. Paint Removal.

A. Parts are coated with paint remover, MIL-R-25134. (MIL-R-25134 - paraffin wax 3 per cent, methylene chloride 72 per cent, wetting agent, alkyl aryl sulfonate or equal 5 per cent, methyl cellulose 2 per cent, methanol 6 per cent, ethylene glycol monoethyl ether 4 per cent, monoethanol amine 5 per cent, water 3 per cent)

B. Hosed off with water.

The two, non-waste producing operations include trichloroethylene (TCE) degreasing, where the parts are placed in TCE vapors, and ultrasonic cleaning of parts.

Wastes produced by the carbon, rust, and paint removal operations include the drippings from parts removed from the various baths and the water used in hosing off the parts. The wastes flow to floor drains then to a sump. From the sump the wastes are pumped to lagoons. Spent PS-661 solution is drained to a tank outside the building and held for burning. During the July study spent PS-661 solution was being hauled to and spread over a land disposal area. Visual observation of the land disposal area indicated that a large part of the waste was being picked up by runoff during rains and carried to the North Ditch.

Wastes from the engine build up shop are pumped to a series of lagoons. The flow to the lagoons is divided equally between two primary lagoons, each with a capacity of 12,350 gallons. At the average flow during the latter study (September 27, 1964 to October 9, 1964) the retention time in the primary lagoons was about two days. Oil is skimmed from the surface of the primary lagoon and drained to a sump pit. The oil is periodically pumped from the pit and removed for burning.

The discharge from each of the primary lagoons flows to secondary lagoons. The secondary lagoons have a capacity of about 170,000 gallons each, providing about 27 days retention at 12,400 gallons of waste per day.

The secondary lagoons discharge to a storm sewer that flows to the North Ditch.

Wastes from the engine build up shop were sampled at three points. The first point was the discharge of the sump pump as the wastes entered the lagoon system. The second was the discharge of the primary lagoons, as it entered the secondary lagoon. The third was the discharge from the secondary lagoons.

Flow measurements were based on meter readings of water use in the engine build up shop and timing the pumping period of the sump pump. Measurement of the secondary lagoon discharge was by means of a V-notch weir. Samples for chemical analysis were composited according to flow over 24-hour periods.

Over twelve sampling days, the quantity of wastes discharged from the engine build up shop averaged 10,000 gallons per day. During three days of sampling, after the new cleaning method had been initiated, the average flow amounted to 12,400 gallons per day.

Results of chemical analysis of samples from the engine build up shop are listed in Table 1 under "Primary Lagoon Influent." Phenol and cyanide concentrations are in micrograms per liter (µg/l) or parts per billion. All other results are in milligrams per liter or parts per million.

Data collected during the two study periods indicate that the quality of wastes discharged from the engine build up shop was not significantly improved by the change in the parts cleaning operation. Flow, ABS, cyanide, chemical oxygen demand, and chromium increased after the new cleaning method had been initiated.

Chemical results obtained from analysis of the secondary lagoon discharge are recorded in Table 1, under "Lagoon Effluent."

The lagoon facilities averaged a reduction of the waste load as follows:

	IN		OUT	
ABS(detergents)	0.75	-	0.13	lbs./day
Oil	228	-	15	lbs./day
Cyanide	27.7	-	12.6	µg./l
Chemical Oxygen Demand	194	-	67	lbs./day
Chromium	0.33	-	0.005	mg./l
Copper	0.4	-	0.1	mg./l
Cadmium	0.13	-	0	mg./l
Nickel	0.4	-	0.02	mg./l

Phenolics increased through the lagoon system.

TABLE NO. 1

WASTE DISPOSAL STUDIES

DOVER AIR FORCE BASE, DOVER, DELAWARE

DATE	Flow Gallons	pH	ABS mg/l	ABS #/day	OIL mg/l	OIL #/day	PHENOLS* µg/l	PHENOLS* #/day	Cyanide* µg/l	COD mg/l	COD #/day	Chromium mg/l	Copper mg/l	Cadmium mg/l	Nickel mg/l	Zinc mg/l
PRIMARY LAGOON INFLUENT - Engine Build Up Shop																
7/26	6,200	7.8	1.2	0.06	904	47	18,100	0.94	--	460	24	0.1	0.9	0	0.85	0
7/27	6,000	9.1	1.08	0.05	3,350	168	41,500	2.1	--	1,500	75	0.5	2.2	0	0.8	0
7/28	9,900	9.1	1.48	0.12	478	39	18,000	1.5	19	1,200	99	0.2	0	0	0	Trace
7/29	11,900	8.9	0.72	0.07	3,120	309	29,000	2.9	33	2,300	228	0	0	0	0	0.
7/30	12,700	8.9	3.92	0.42	10,700	1,140	25,400	2.7	6.3	1,300	137	0	1.8	0	4.4	0.85
7/31	10,300	9.0	1.44	0.12	3,380	290	14,300	1.2	20	1,400	120	0.2	0	0	0	0
8/1	9,000	9.1	0.68	0.05	838	63	5,850	0.44	12	1,700	127	0	0	0	0	0
9/27	7,900	8.8	1.98	0.13	173	11	8,540	0.56	0	650	42	0	0	0.21	0	0
9/28	9,100	9.2	18.	1.36	185	14	25,000	1.9	0	1,900	144	0.31	0	0	0	0
10/6	11,100	9.3	30.	2.78	990	92	17,900	1.7	46	3,500	324	1.2	0	0.92	0	1.47
10/7	10,900	9.3	24.7	2.25	307	28	17,900	1.6	25	1,600	145	0	0	0.65	0	0
10/8	13,200	10.2	12.3	1.56	4,180	530	14,300	1.8	118	6,000	760	1.75	0.1	0	0	0.01
10/9	--	9.2	5.38	--	278	--	100,000	--	25	2,200	--	0	0	0	0	0
AVG.	10,000	9.1	7.91	0.75	2,200	228	25,800	1.61	27.7	1,980	194	0.33	0.4	0.13	0.4	0.2
MAX.	15,200	10.2	30.	2.78	10,700	530	100,000	2.9	118.	6,000	760	1.75	2.2	0.92	4.4	1.47
MIN.	6,000	7.8	0.72	0.05	173	11	5,850	0.44	0.	460	24	0.	0.	0.	0.	0.
PRIMARY LAGOON EFFLUENT																
9/27	7,900	9.3	1.8	.12	689	45	561,200	37.	0	4,700	310	11.97	0	0	0	0
9/28	9,100	9.0	2.	.15	284	22	281,750	21.	0	2,600	197	0.7	0	0	0	0
10/6	11,100	9.3	7.	.65	254	24	20,300	2.	7.6	2,000	185	0.32	0	0	0	0
10/7	10,900	9.4	5.	.45	247	22	13,575	1.	13.1	2,200	200	1.14	0	0	0	0
10/8	15,200	10.6	3.3	.42	195	25	14,425	2.	14.7	1,000	380	0	0	0	0	0
10/9	--	9.7	2.6	--	206	--	13,525	--	0	2,000	--	0	0	0.76	0	0
AVG.	10,840	9.6	3.6	0.36	313	28	150,800	13.	5.9	2,750	250	2.34	0	0.13	0	0
MAX.	15,200	10.6	7.	0.45	689	45	561,200	37.	14.7	4,700	380	11.97	0	0.76	0	0
MIN.	7,900	9.0	1.8	0.12	195	22	13,525	1.	0.	2,000	185	0	0	0.00	0	0

* Micrograms per liter or parts per billion.

(Cont'd.)

WASTE DISPOSAL STUDIES

DOVER AIR FORCE BASE, DOVER, DELAWARE

DATE	Flow Gallons	pH	ABS mg/l	ABS #/day	OIL mg/l	OIL #/day	PHENOLS* µg/l	PHENOLS* #/day	Cyanide* µg/l	COD mg/l	COD #/day	Chromium mg/l	Copper mg/l	Cadmium mg/l	Nickel mg/l	Zinc mg/l
LAGOON EFFLUENT																
7/26	3,500**	8.5	1.8	0.05	954	28	16,300	0.5	-	600	18.	0.15	0.00	0	0.00	0
7/27	3,500**	9.1	1.48	0.04	128	3.7	23,650	0.7	-	700	20	0	0.4	0	0.2	0
7/28	8,100	9.1	1.48	0.1	65	4.4	19,175	1.0	3.7	640	43	0	0	0	0	0.5
7/29	8,400	8.9	1.6	0.11	111	7.8	9,325	0.7	0.	760	53	0.4	0	Trace	0	0
7/30	9,000	9.3	3.2	0.24	446	33.	18,780	1.	12.6	760	57	0	0	0	0	0
7/31	8,200	9.2	0.88	0.06	169	12.	17,850	1.	11.7	790	54	0	0	0	0	0
8/1	6,800	9.3	0.96	0.05	195	11.	17,975	1.	16.1	870	49	0	0	0	0	0
9/27	4,480	8.7	2.15	0.08	0	4.6	115,300	4.	0.	1400	52	0	1.26	0	0	2.
9/28	-	-	-	-	123	-	-	-	-	-	-	-	-	-	-	-
10/6	8,600	7.3	3.29	0.24	224	16.	92,700	7.	43.9	1400	100	0	0	0	0	0
10/7	8,600	8.4	2.36	0.17	270	19.4	88,600	6.	15.9	1400	100	0	0	0	0	0
10/8	11,500	8.4	2.27	0.22	278	26.6	84,600	8.	22.2	1500	144	0	0	0	0	0
10/9	9,400	8.6	2.36	0.18	176	13.8	73,000	6.	12.7	1500	117	0	0	0	0	0
AVG.	7,500	8.7	1.98	0.13	241	15.	48,100	3.	12.6	1027	67	.005	0.14	0	0.021	0.2
MAX.	11,500	9.3	3.29	0.24	954	33.	115,300	8.	43.9	1500	144	0.4	1.26	0	0.25	2.
MIN.	3,500	7.3	0.88	0.04	65	3.7	16,300	0.5	0.	600	18	0.	0.	0	0.	0.
BASE RACK INFLUENT																
9/28	35,000	8.9	29.2	7.4	-	-	6,270	0.2	-	-	0	0.	0.4	0.25	0	0
10/6	47,800	8.6	28.4	11.3	10,038	4,000	146	0.06	-	-	0	0	0	0	0	0
10/7	40,800	8.8	-	-	945	321	158	0.05	-	11,000	3,743	0.07	0	0	0.01	0.08
10/8	41,700	8.5	32.3	11.2	3,090	1,074	185	0.06	-	3,700	1,287	0	0.3	0	0	0
10/9	23,850	8.7	33.4	6.6	2,563	509	230	0.05	-	2,800	557	0.03	0.1	0.06	0	0.34
AVG.	37,830	8.7	30.8	9.1	4,159	1,475	1,398	0.08	-	3,500	1,117	0.02	0.16	0.05	0.06	0.08
MAX.	47,800	8.9	33.4	11.3	10,038	4,000	6,270	0.02	-	11,000	3,743	0.3	0.4	0.25	0.01	0.34
MIN.	23,850	8.5	28.4	6.6	945	321	146	0.05	-	2,800	557	0.	0.0	0.	0.	0.

* Micrograms per liter or parts per billion.

** Divided Flow

(Cont d.)

WASTE DISPOSAL STUDIES

DOVER AIR FORCE BASE, DOVER, DELAWARE

DATE	Flow Gallons	pH	ABS mg/l	ABS #/day	OIL mg/l	OIL #/day	PHENOLS* µg/l	PHENOLS* #/day	Cyanide* µg/l	COD mg/l	COD #/day	Chromium mg/l	Copper mg/l	Cadmium mg/l	Nickel mg/l	Zinc mg/l
WASH RACK EFFLUENT																
7/26	Not Operating		-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/27	15,600	8.9	22.6	3	-	-	1,420	.2	-	950	123.	0.5	0	0.5	0.15	0.45
7/28	18,200	9.0	10.7	2	415	63	676	.1	-	330	50.	0	0	0.25	0.10	0
7/29	12,100	9.0	20.7	2	193	19	1,082	.1	-	2,100	212	0.4	0.05	0.7	0.10	0.3
7/30	21,700	9.1	28.	5	164	30	325	.06	-	610	110	0.7	0	0.3	0.10	0
7/31	14,600	9.0	19.6	2	90	11.	206	.03	-	380	46	0.35	0	0.6	0.05	0
8/1	Not Operating		-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/28	30,500	8.7	30.4	8	157	40	5,630	1.	-	-	0	0	0.1	0	0	0.40
10/6	47,800	8.5	28.	11	93	37	178	.07	-	260	104	0	0.16	0.05	0	0
10/7	40,800	8.6	48.8	17	604	205	193	.7	-	0	0	0	1.00	0.13	0.08	1.27
10/8	41,700	8.3	27.2	9	129	44	185	.06	-	680	236	0	0	0	0	0
10/9	23,850	8.8	29.2	6	173	34	162	.03	-	1,200	239	0	0	0	0	0
AVG.	26,685	8.8	26.5	7	200	54	1,000	.24	-	650	112	0.2	0.01	0.26	0.06	0.24
MAX.	47,800	9.1	48.8	17	604	205	5,630	1.	-	2,100	239	0.7	1.00	0.7	0.15	1.27
MIN.	12,100	8.3	10.7	2	90	11	162	.03	-	260	50	0.	0.	0.	0.05	0.
CADMIUM PLATING SHOP																
7/30	1,335	11.5	9	0.1	-	-	-	-	857	210	2.	0.1	0.4	0.7	0	0
10/7	624	-	1.98	0.01	-	-	-	-	20.3	46	0.24	0.04	0.12	1.68	0.35	0
10/8	878	6.7	1.86	0.01	-	-	-	-	113	42	0.31	0.01	0.09	2.88	0	0
10/9	934	5.6	2.02	0.01	-	-	-	-	79.4	42	0.33	0.02	0.05	4.69	0.02	0
AVG.	943	6.2	3.72	0.01	-	-	-	-	267	43	0.29	0.04	0.17	2.49	0.09	0
MAX.	1,335	11.5	9	0.1	-	-	-	-	857	46	0.33	0.04	0.4	4.69	0.35	0
MIN.	624	5.6	1.86	0.03	-	-	-	-	20.3	42	0.24	0.01	0.05	0.7	0.00	0

* Micrograms per liter or parts per billion.

TABLE NO. 1
(Cont'd.)

WASTE DISPOSAL STUDIES

DOVER AIR FORCE BASE, DOVER, DELAWARE

NORTH DITCH

DATE	Flow Gallons	pH	ABS mg/l	ABS #/day	OIL mg/l	OIL #/day	PHENOLS* µg/l	PHENOLS* #/day	Cyanide* µg/l	COD mg/l	COD #/day	Chromium mg/l	Copper mg/l	Cadmium mg/l	Nickel mg/l	Zinc mg/l
7/26	146,000	7.2	0.6	0.73	4.2	5.	20.7	.03	-	58	70	0.10	0	Trace	0	0
7/27	177,000	7.5	0.4	0.59	7.1	10.	6.4	.01	-	40	60	0	0	0	0	0
7/28	236,000	7.6	1.6	3.15	28.	55.	23.6	.05	-	100	200	Trace	0	0	0	0
7/29	288,000	7.2	2.0	4.8	55.	132.	34.4	.08	0	210	500	0	0	0	0	0
7/30	189,000	7.4	1.28	2.	55.	87.	19.1	.03	7.9	160	250	0	0	0	0	0
7/31	189,000	7.3	2.	3.15	38.	60.	19.7	.03	18.8	86	140	0	0	0	0	0
8/1	167,000	7.6	1.4	1.95	21	29.	15.7	.02	2.6	67	90	0.15	0	0	0	0
9/27	135,400	7.5	2.55	2.88	16.7	19.	106.5	.1	0	110	120	0	0	0	0	0
10/6	321,100	7.3	2.54	6.8	31.8	85.	228.	.06	28.8	38	100	0.15	0	0	0	0
10/7	169,900	7.4	2.47	3.5	38.9	55.	1175.	2.	0	260	370	0.14	0	0	0	0
10/8	177,000	7.3	2.85	4.21	59.1	87.	1692.	3.	8.7	270	400	0.12	0	0	0	0
10/9	174,000	7.6	3.17	4.6	54.0	78.	1216.	2.	0	130	190	0.18	0.4	0	0	0
AVG.	197,500	7.4	1.91	3.2	34.06	59	379.7	.6	7.4	127	210	0.07	0.03	0	0	0
MAX.	321,100	7.6	3.17	6.8	59.1	132	1692.	3.	28.8	270	500	0.18 ~~0.15~~	0.40	Trace	0	0
MIN.	135,400	7.2	0.4	0.59	4.2	5	6.4	.01	0.0	38	60	0.	0.	0	0	0

AIRCRAFT WASH RACK

Two aircraft wash racks are provided. One is used by the Military Air Transport Service (MATS) aircraft, and the second is used for Strategic Air Command (SAC) aircraft. Both racks operate one shift per day, five days per week and both discharge to a common treatment unit.

The aircraft wash racks use the following compounds in their cleaning operations:

1. Water base alkaline cleaner, MIL-C-25769 (MIL-C-25769 - trisodium phosphate 10 per cent, ethylene glycol mono-ethyl ether 6 per cent, non-ionic surfactant 2 per cent, water 82 per cent. Approximately 1,000 to 1,200 lbs. of alkaline water base cleaner are used per week, mixed at 20 lbs. of cleaner to 50 gallons of water.
2. Dry-cleaning solvent, PS-661b, Type II, use 500 gallons per week new, plus 250 gallons per week relcaimed from treating unit (defined under "Engine Build Up Shop, I. Carbon Removal").
3. Metal conditioner and brightener, * aluminum surface, MIL-C-25378 (MIL-C-25378 - n-butyl alcohol 40 per cent, i-propyl 30 per cent, 85 per cent o-phosphoric acid 10 per cent, water 20 per cent).

*NOTE: No skin brightener is used on MATS aircraft. SAC aircraft are polished occasionally in the summer months using material as mentioned in "3" above.

The treatment unit is essentially a skimming tank for oil separation. The skimmed oil is re-used in the plane washing operations.

Samples were obtained of the wash rack wastes entering the treatment unit during the latter phase of the study only. The discharge from the treatment unit was sampled during both phases of the study. Samples were composited according to flow during the operating shift.

Results obtained from chemical analysis of the wash rack wastes are recorded in Table 1, under "Wash Rack Influent" (untreated waste), and "Wash Rack Effluent" (treated waste). A considerable increase in water use occurred during the latter phase of the study. Use increased from an average of 16,000 gallons per day during July, to an average of 37,000 gallons per day during the October study.

The wash rack treatment unit reduced the waste load as follows:

ABS(detergents).....	29 per cent
Oil.....	97 per cent
Chemical Oxygen Demand.....	89 per cent

Average values for phenolics indicate a decrease; however, in general they were not significantly affected by the treatment.

Significant quantities of heavy metals were present in the treated wastes. The treating unit did not remove the heavy metals picked up in the plane washing operations.

CADMIUM PLATING SHOP

The cadmium plating shop operates sporadically as necessary. Usual operation is not more than one or two days per week. The quantity

of wastes produced is generally less than 1,000 gallons for an operating day of one shift.

The procedure used is as follows:

1. Parts are electro-cleaned in PC-535, 120-gallon tank. (PC-535 - cleaning compound, plater: electro-cleaning, for steel-sodium hydroxide 3 oz. per gallon water, sodium carbonate 4 oz. per gallon water, trisodium phosphate 1 oz. per gallon water, alkyl aryl sulfonate 1/2 oz. per gallon water)
2. Water rinse tank.
3. Muriatic acid bath, 80-gallon tank containing 50 per cent water and hydrochloric acid 20° Baume.
4. Water rinse tank.
5. Cadmium plating tank - 280 gallons (sodium cyanide, 16 oz. per gallon water, cadmium oxide 4.5 oz. per gallon water, cadmium salt brightener 4 oz. per 100 gallon water.
6. Water rinse.
7. Bright dip tank, 50-gallon drum containing 1/2 gallon concentrated nitric acid and filled with water.
8. Water rinse.

Waste from the cadmium plating shop discharges directly to the storm sewer draining to the North Ditch. The possibility of leaks, particularly from the cadmium plating tank, presents a potential hazard.

Should a break in the tank occur, large quantities of cyanide and cadmium would be discharged to the storm sewer and then into Pipe Elm Branch, and eventually to Little River. The plating tank contains sufficient cyanide (146 lbs.) to cause a concentration of 87 mg./l in the North Ditch, if the tank were emptied over a 24-hour period.

The tank also contains sufficient cadmium (69 lbs.) to cause a concentration in the North Ditch of 41 mg./l.

At times the flow in the North Ditch makes up 90 per cent of the flow in Pipe Elm Branch. Should an accidental spill occur in the plating shop an extremely serious problem would result.*

Samples were collected from the plating operation wastes for four days. The results obtained by chemical analysis of the samples are recorded in Table 1, under "Cadmium Plating Shop."

SANITARY WASTES

All sanitary wastes from the Base and the Base housing development are treated by a primary treatment plant and discharged to an arm of the St. Jones River.

Samples were collected from the influent and effluent of the treatment plant over nine, eight-hour shifts. Samples were composited over each of the eight-hour periods according to flow.

*NOTE: This problem was discussed February 18 and 19 on the phone by A. D. Sidio and Lieut. Robert F. Rakowski. Lieut. Rakowski stated that a work order was issued on February 19 to install the necessary facilities to prevent such an accidental spill to the storm sewer.

The results obtained from analyses of samples collected from the sewage treatment plant are listed in Table 2.

The efficiency of a sewage treatment plant is generally determined by the reduction of biochemical oxygen demand (BOD) and suspended solids. Average BOD of the influent samples was 165 milligrams per liter (mg./l). BOD of the effluent was 123 mg./l. This is a reduction of 25 per cent. Suspended solids in the influent averaged 122 mg./l and the discharge averaged 59 mg./l. This is a reduction of 52 per cent.

Flow during the 5-day sampling period averaged just slightly over 700,000 gallons per day. With 123 mg./l of BOD in the effluent, the discharge has a BOD population equivalent of 4,300.

During the time of the study chlorination of the treated sewage was carried on only during the day shift (0700 to 1500). The reason for this was the lack of an adequate water supply to run the chlorinator. The water for this use was being pumped from a well. At the time of the study a water line was being extended to the disposal plant from the Base water distribution system.

Influent samples ranged from 4.5 million to 20 million coliform bacteria per 100 ml. Samples collected in the afternoon were collected while the discharge was being chlorinated. Only one sample was obtained in the morning when the chlorinator was not in operation. The result on that sample was above the limit of dilutions made. The dilutions used indicated an MPN of at least 1 million per 100 ml. When the effluent was being chlorinated, 5,000 coliform per 100 ml. were present.

Table II

WASTE DISPOSAL STUDIES
Dover Air Force Base

	9 OCT 1964				8 OCT 1964				7 OCT 1964				28-29 SEPT 1964				27-28 SEPT 1964	
	AM COMP		PM COMP		AM COMP		PM COMP		AM COMP		PM COMP		AM COMP		PM COMP		PM COMP	
	I	E	I	E	I	E	I	E	I	E	I	E	I	E	I	E	I	E
Acidity mg/l	29	35	38	40	34	28	22	30	39	45	26	13	--	--	--	--	--	--
Tot Alk mg/l	287	279	269	268	275	284	300	280	301	298	265	301	--	--	--	--	--	--
BOD mg/l	146	120	159	138	137	129	200	102	139	133	186	111	157	145	184	102	176	126
COD mg/l	420	240	680	980	294	249	530	200	387	274	379	206	311	237	311	172	266	209
pH	7.6	7.4	7.6	7.4	7.6	7.6	8.0	7.5	7.6	7.3	7.4	8.9	--	--	--	--	--	--
Tot Sus Solids mg/l	140	64	94	80	152	48	118	38	102	50	120	112	174	42	140	56	86	42
Vol Sus Solids mg/l	60	12	30	12	--	--	--	--	54	24	44	90	140	28	114	30	58	28
Non Vol Sus Sol mg/l	80	52	64	68	--	--	--	--	52	26	76	22	34	14	26	26	28	14
Total Nitrogen mg/l	30.8	24.6	26.0	29.4	23.2	24.9	35.0	28.0	26.0	22.7	41.7	29.1	--	--	--	--	--	--
Organic Nitro. mg/l	12.9	9.5	9.2	9.8	7.8	7.6	12.6	12.0	9.5	7.0	12.3	8.7	--	--	--	--	--	--
NH3-N mg/l	17.9	15.1	16.8	19.6	15.4	17.3	22.4	16.0	16.5	15.7	29.4	20.4	--	--	--	--	--	--
NO3-N mg/l	2.5	0.7	2.2	1.2	1.2	2.5	0.6	2.2	1.2	0.7	1.4	0.8	--	--	--	--	--	--
E Coli #/100 ml	--	--	--	--	--	--	--	--	--	--	--	--	4.5mm	>1mm	19.6mm	4600	6.3mm	0.1mm
Flow mgd	0.733				0.731				0.746				0.656				0.671	

I Influent
E Effluent
m 1 Thousand
mm 1 Million

NORTH DITCH

During dry seasons the flow of the North Ditch represents about 90 per cent of the flow in Pipe Elm Branch.

Flow measurements of the North Ditch were made by means of a V-notch weir. Flow varied from 135,000 to 321,000 gallons per day. The average flow was slightly less than 200,000 gallons per day. Approximately 50,000 of the 200,000 gallons per day were from industrial or operational wastes. The remaining flow was made up of drainage from the Base.

Samples were collected from the North Ditch during both phases of the study. Samples were composited according to flow over 24-hour periods. Results of chemical analysis on samples collected are recorded in Table 1 under "North Ditch."

The results obtained show that wastes discharged from the Base were not improved by the change in cleaning operations in the engine build up shop. Data through July 31 were of samples collected before the change-over was made. Data from September 27 were after the change-over. ABS, Phenol and Chromium levels increased in the wastes after the change-over.

Of the twelve samples collected from the North Ditch during the two study periods, ABS levels exceeded 1 mg./l in 10.

An average of 59 lbs./day of oil was discharged from the Base in the North Ditch. Concentrations ranged from 4.2 to 59 mg./l.

Phenols averaged 0.6 lbs./day in the North Ditch. During the second study period (after September 27) the average load was 1.4 lbs./day.

Concentrations of phenols were as high as 1,700 micrograms per liter. Values during the first study period did not exceed the 0.1 lbs./day objective limit of the Delaware Water Pollution Commission. During the second study period the limit was exceeded in 4 out of 5 samples.

Detectable quantities of cyanide were observed in 5 of 9 samples in the North Ditch. The 1962 Public Health Service Drinking Water Standards recommends that concentrations of cyanide be kept below 0.01 mg./l or 10 µg./l. Cyanide Standards are generally based on toxicity to fish and not to man. For the protection of health of human populations concentrations above 0.2 mg./l constitute ground for rejection of the supply. Since the use of Little River includes fishing, the 0.01 mg./l level is considered here to be required. This amounts to 0.02 lbs./day in 200,000 gpd flow. The maximum value was 0.03 mg./l, or 30 µg./l.

Chemical oxygen demand (COD) levels in the North Ditch ranged from 60 to 500 lbs./day. The average value was 210 lbs./day, exceeding the objective limit of 25 lbs./day by eight times.

Chromium concentrations were quite low during the first study period in the North Ditch. Concentrations increased during the second study period. Four out of five samples during the study period had concentrations of 0.12 mg/l or more. The four positive samples exceeded the objective limit of 0.05 lbs./day by as much as six times (0.3 lbs./day).

Copper was found in one of twelve samples collected from the North Ditch. The concentration of 0.4 mg./l amounted to 0.58 lbs./day,

exceeding the objective of 0.1 lbs./day by six times.

Cadmium, Nickel and Zinc were not observed in detectable quantities in the North Ditch. In one sample a trace of Cadmium was present.

BIOLOGICAL STUDIES

NORTH DITCH, PIPE ELM BRANCH, AND LITTLE RIVER

Biological collections and field observations were made during the period September 29 to October 2, 1964, to evaluate effects of industrial waste discharge from the Dover Air Force Base on aquatic life in the receiving streams. The streams studied were Little River and Pipe Elm Branch, a tributary to Little River; all reaches studied are at times under tidal influence.

Seven stream stations were sampled on Little River and Pipe Elm Branch; their locations were as follows (Chart 2):

1. North Ditch - on Dover Air Force Base property, 300 feet upstream from formation of Pipe Elm Branch.
2. Pipe Elm Branch - three-fourths of a mile downstream from Dover Air Force Base boundary.
3. Pipe Elm Branch - 250 feet upstream from confluence with Little River.
4. Little River - one-half mile upstream from confluence with Pipe Elm Branch.

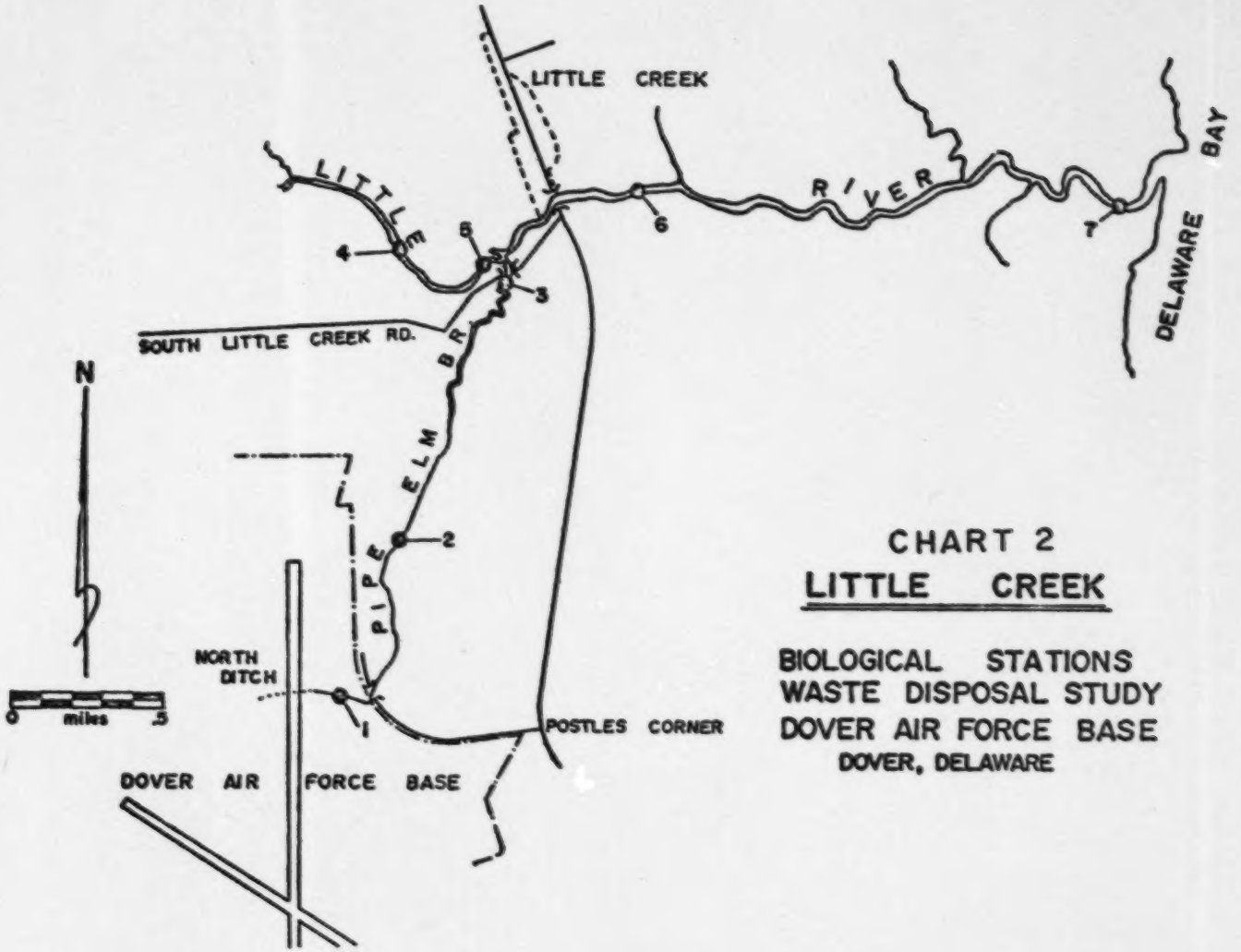

CHART 2

LITTLE CREEK

BIOLOGICAL STATIONS
WASTE DISPOSAL STUDY
DOVER AIR FORCE BASE
DOVER, DELAWARE

5. Little River - 250 feet upstream from confluence with Pipe Elm Branch.
6. Little River - one-half mile downstream from confluence with Pipe Elm Branch.
7. Little River - one-fourth mile upstream from Delaware Bay.

All stations are normally influenced by tides. The bottom organism populations of unpolluted estuarine habitats are primarily determined by salinity. In general, as salinity levels increase in estuary, fresh-water organisms are replaced by marine forms; thus, for any reach in a non-polluted tidal stream, the various habitats should support fresh-water or marine forms, or both.

The North Ditch on the Dover Air Force Base and the reach of Pipe Elm Branch, from its formation to a point approximately 300 feet upstream from its confluence with Little River, were practically devoid of bottom organisms. A few sludgeworms were present near the high tide mark three-quarters of a mile downstream from the Air Base on Pipe Elm Branch (Station 2). The composition of the bottom materials for this reach consisted of natural organic detritus intermixed with black, oily, greasy sludge. The emission of decomposition gases was evident. Sludge was lacking at Station 3, where the bottom consisted of hard, blue clay and some natural organic detritus that was covered with an oily film. From a point immediately upstream from Station 3, and downstream some 300 feet to the confluence with Little River, there was little deposition of material on the stream bottom because of the

velocity of the tides in this reach. Five kinds of marine bottom organisms were collected from Station 3 (Table 3).

From Station 5, 250 feet upstream from the confluence with Pipe Elm Branch, on Little River to one-half mile upstream (Station 4) bottom organism populations were found that were greater both in number of kinds and in total numbers than were found in Pipe Elm Branch at Station 3. This reach of Little River was "virtually alive" with shrimp as opposed to only a scattered few in Pipe Elm Branch. The stream bed in the reach of Little River was composed of fine silt, mud and natural organic detritus. No grease or oil was evident. The bottom organism population in Little River upstream from the junction (Station 5) had two additional marine forms, sea anemones and isopods, as opposed to populations one-half of a mile further upstream. This is attributed to the increased salinity levels at Station 5.

The kinds of bottom organisms found at Station 6, which is downstream from the junction of Pipe Elm Branch, were not significantly different than those found at Station 5. However, the stream bed in this area which was covered with water during low tides consisted of black, oily sludge similar to that observed in Pipe Elm Branch upstream from Station 3. The bottom population in this sludge was sparse, only a few marine worms; whereas, the exposed mud banks at this station that are flooded at higher tides supported a more diverse and abundant population (Table 3).

Downstream on Little River one-fourth of a mile upstream of Delaware Bay, at Station 7, there was no evidence of an oily sludge

TABLE 3

BOTTOM ORGANISM DATA
PIPE ELM BRANCH - LITTLE RIVER
KINDS AND NUMBERS OF ORGANISMS PER SQUARE FOOT

OCTOBER 1-2, 1964*

	PIPE ELM BRANCH			LITTLE RIVER			
	#1	#2	#3	#4	#5	#6	#7
Sea-anemones							
Actiniaria	-	-	-	-	65	Q	3
Segmented Worms							
Polycheata							
Nereis sp.	-	-	34	3	2	3	36
Glycera sp.	-	-	-	2	-	Q	3
Eteone sp.	-	-	2	37	19	7	5
Streblospio sp.	-	-	85	65	44	26	60
Amphicteis sp.	-	-	-	-	10	-	14
Nerine sp.	-	-	-	-	-	7	3
Oligochaeta	-	Q	7	126	3	-	17
Hirudinea (Leeches)	-	-	-	-	-	3	12
Barnacles							
Balanus sp.	-	-	-	Q	Q	-	Q
Sow-bugs (Icapoda)							
Edotea sp.	-	-	3	-	124	2	Q
Cyathura sp.	-	-	-	-	Q	Q	-
Scuds (Amphipoda)							
Stenothoe sp.	-	-	-	-	-	-	2
Crabs							
Rhithropanopeus sp.	-	-	-	Q	3	Q	39
Mussels							
Brachidontes sp.	-	-	-	Q	-	-	2
Snails							
Nassa sp.	-	-	-	-	-	-	7
Unknown	-	-	-	-	-	2	-
TOTAL KINDS	0	1	5	8	10	11	15
TOTAL NUMBER PER/SQ. FT.		1	131	236	272	53	205

PIPE ELM BRANCH ENTERS

* Tentative Identification

Q From qualitative sample, given a value of 1 in quantitative total

or even an oil film on the various substrates. The marine benthic population at this station was more diversified and consisted of greater numbers than at Station 6. This is attributed to higher salinities, less polluted bottom materials, and closer proximity to Delaware Bay.

Various components of the Dover Air Base industrial wastes from the engine build up shop, aircraft wash rack and plating plant, that eventually enter the Little River drainage are toxic to aquatic life or in some manner adversely affect it. These toxic constituents include cadmium, chromium, copper, cyanide, nickel, oil, phenol, and zinc. These potentially toxic wastes would be more concentrated in Pipe Elm Branch at low tide than any location in Little River because of dilution. Phenolic compounds may affect fish in two ways: by direct toxic action, and by imparting taste to fish flesh. Phenol levels of 1.7 mg./l were determined in samples from the North Ditch during the study. Phenols in mixed wastes at concentrations of 0.05 mg./l have been known to cause taste in fish flesh and adversely affect aquatic life.

Oil was in evidence in the wastes from the Dover Air Force Base; it was observed as film on water and exposed substrates, and combined with bottom sediments in both Pipe Elm Branch and Little River. Concentrations of oil up to 59 mg./l were determined in samples from the North Ditch. Oil in wastes can affect aquatic life in the following manner: exert a direct toxic action, coat body

surfaces of birds and fish, impart taste to fish flesh, coat and destroy aquatic plants, interfere with gas exchange, and settle to the bottom thus destroying bottom organisms and interfering with fish spawning areas.

The cadmium and cyanide levels measured were below known toxic levels for fish, however, the storage of large volumes of these materials at the air base plating operation does present a potential hazard to the aquatic life in the Little River drainage.

The North Ditch (Station 1) and that portion of Pipe Elm Branch downstream to approximately 250 feet above its confluence with Little River (Station 3) were biologically degraded because of the oily, greasy sludge that covers the bottom thus smothering bottom life, and that may also exert a toxic effect on bottom organisms. The same environmental conditions existed in Little River from this confluence for at least one half mile downstream (Station 6). In the section of Pipe Elm Branch immediately above the confluence with Little River (Station 3) the oily sludge was not present, however, toxicity was indicated when its benthic population was compared to the diversified population present in Little River, 250 feet upstream of the confluence of Pipe Elm Branch (Station 5). The salinity levels at Stations 3 and 5 are comparable and therefore have little or no affect on the benthic diversification at these stations.

ST. JONES RIVER

Biological collections and field observations were made on October 1, 1964, on the St. Jones River at two stations, both of which were under tidal

influence. The two stations bracketed the Dover Air Force Base sewage treatment plant outfall; one was one-half mile upstream of the outfall and the other was one-half mile downstream from it. The water was a dingy, gray-black; domestic wastes were floating on or suspended in the water; bottom materials consisted of organic sludge, silt, and plant detritus all covered with an oil film; organic sludge banks were common; gas emission was evident; and a sewage odor persisted. This entire stretch was biologically degraded. Only one blood worm and one marine worm were found at the upstream station, and no organisms were found at the downstream station. The Dover Air Force Base sewage treatment plant effluent contributes to the pollution and degradation of the St. Jones River both above and below its outfall.

COMPARISON 1963-1964 DATA

Chemical analyses were made on the Dover Air Force Base industrial wastes during 1963 by the Kelly Air Force Base laboratories. Some analyses were performed by the Delaware Water Pollution Commission laboratories. Seven sets of samples were obtained from September 24 through November 19, 1963.

Flow from the engine build up shop was reduced by about one-half from 1963 to 1964. This was accomplished by the use of self-closing nozzles on hoses. By reducing the flow, the retention time in the lagoons was proportionately increased.

Discharge from the lagoons was considerably improved. ABS (detergent) was reduced by about 90 per cent. Phenol was reduced by about 50 per cent. Chemical oxygen demand was reduced by about 75 per cent. Cyanide was not detected in the 1963 samples. Concentrations as high as 44 micrograms per liter (parts per billion) were detected during 1964. Chromium was the only heavy metal analysis made during 1963. Quantities of Chromium were greater during 1963.

Flow from the aircraft wash racks remained about the same. Phenol, ABS, C.O.D., and Chromium discharged from the plane washing operations remained about the same.

The number of samples and duration of operating periods of the Cadmium plating shop are inadequate to compare 1963 and 1964 data.

Flow in the North Ditch consists of all the industrial wastes from the Base plus additional drainage. Flows in the North Ditch during the 1963 and 1964 study periods were comparable.

The quantity of Phenol discharged from the Base by the North Ditch was reduced by 98 per cent. ABS was reduced more than 50 per cent. Chemical oxygen demand remained about the same. Quantities of Chromium increased, particularly during the latter study of 1964.

Over-all the quality of wastes discharged during the 1964 studies was considerably improved over the quality of 1963.

APPENDIX

35

HEADQUARTERS
DOVER AIR FORCE BASE (MATS)
UNITED STATES AIR FORCE
Dover Air Force Base, Delaware

Anderson

20 APR 1964

REPLY TO
ATTN OF:

SUBJECT: Request for Technical Assistance

TO: Mr. Earl J. Anderson
Public Health Service - Room 1049
42 Broadway
NY 14 NY

Dear Mr. Anderson

1. As you know from our meeting of 4 September 1963, the base is making every effort to evaluate the possible toxicity of our industrial waste effluent. In the past, we have been able to analyze our samples at the Delaware State Water Pollution Laboratory and the USAF Environmental Health Laboratory at Kelly Air Force Base, Texas. However, due to the inherent time delay in getting the samples to Kelly AFB and analyzing them (as much as 14 days), the accuracy of the results is known to be in serious error. In addition, Mr. Bryson, Delaware Water Pollution Commission, states that he will be unable to provide the necessary laboratory support because of a critical shortage of trained personnel.

2. Since December, we have planned and are making several significant changes in the use of chemicals and procedures which should substantially change the characteristics of our waste effluent from that evaluated previously. These operations should be stabilized by June 1.

3. In view of the above, I request that you provide the full time services of one industrial waste engineer and one industrial waste chemist. Their duties would be to supervise and accomplish the laboratory analysis of the waste, to augment my staff in the evaluation of this program, and to recommend corrective action if deemed necessary. Mr. Bryson has graciously consented to place his laboratory facilities at your disposal. We will provide the manpower needed to accomplish this project, including one or two laboratory technicians who are now in training. I, therefore, request that these men be made available on or about June 1st for whatever period of time is necessary for successful completion.

4. Thank you for your cooperation, and I trust that I will be hearing from you in the very near future.

Sincerely

Lloyd R. Humphreys

LLOYD R. HUMPHREYS
Colonel, USAF
Commander

Region II
42 Broadway
New York, New York 10004

May 24, 1965

In reply refer to:
24:WPC

Floyd I. Hudson, M. D.
Executive Officer
Water Pollution Commission
State of Delaware
Attn: John C. Bryson, Director
Water Pollution Control

Dear Dr. Hudson:

This will confirm the discussions during the May 20th meeting between personnel of the Delaware Water Pollution Commission, Dover Air Force Base and the Public Health Service. The report reviewed at this meeting will be revised to recommend that industrial waste facilities be designed to meet the following objectives:

Phenolics	0.1 lbs/day
Chromium	0.05 lbs/day
Chemical Oxygen Demand	25 lbs/day
Copper	0.10 lbs/day
Alkyl Benzene Sulfonate	1.67 lbs/day
Cyanide	0.02 lbs/day
Cadmium	0.03 lbs/day
Nickel	0.33 lbs/day
Zinc	8.32 lbs/day
Oil	25. lbs/day

While it is realized that design problems may require some flexibility in these objectives, those listed above for Phenolics, Chromium, Copper, Alkyl Benzene Sulfonate and Floating Oil are to be considered as firm upper limits.

As indicated at the meeting, officials of the Dover Air Force Base will require specific acceptable objectives to enable them to proceed with budget requests for a satisfactory abatement program.

We would appreciate a letter of confirmation for our report.

Sincerely yours,

Earl J. Anderson
Regional Program Director
Water Supply and Pollution Control

CC: Col. S. R. Humphreys
Mr. A. Sidio
Mr. E. MacLeman

COPY

WATER POLLUTION COMMISSION
State of Delaware
DOVER, DELAWARE 19901

May 27, 1965

Mr. Earl J. Anderson
Regional Program Director
Water Supply & Pollution Control
Department of Health, Education & Welfare
42 Broadway
New York, New York 10004

Dear Mr. Anderson:

Thank you for the letter listing the objectives to be met by the proposed industrial waste facilities at the Dover Air Force Base. We confirm all objectives with one clarification. The objective for oil stated at 25 lbs/day is for dissolved oil only. It is agreed that no floating oil would be tolerated.

Thank you.

Very truly yours,

N. C. Vasuki (Signed)

N. C. Vasuki
Sanitary Engineer

NCV:lb

WATER POLLUTION COMMISSION
STATE OF DELAWARE
DOVER, DELAWARE

Governor

February 15, 1965

Colonel David E. Daniel
160th Air Transport Wing
Dover Air Force Base
Dover, Delaware

Dear Colonel Daniel:

The St. Jones River has shown definite degradation in water quality during the past several years. The present quality certainly is not in keeping with the best water usage of the area. The demand for public recreational use of this stream has increased significantly during the past year.

The odor conditions experienced on the river last summer were partially due to discharges from the Dover Air Force Base sewage treatment facilities. In order to correct this situation the City of Dover and Delaware State College, the other dischargers, have installed secondary sewage treatment facilities.

To prevent further degradation of water quality in the St. Jones River, it will be necessary that Dover Air Force Base provide secondary waste treatment facilities. Your attention is called to the St. Jones River Drainage Basin Study Report of July, 1961, in which secondary treatment was recommended for the Dover Air Force Base.

Very truly yours,

John C. Bryson

John C. Bryson
Director

JCB:dm

C.C. Colonel Lloyd R. Humphreys
Base Commander, DAFB

Mr. Earl J. Anderson
Regional Program Director, USPHS